Bilberry Creek 2015 Summary Report

Watershed Features	
Area	13.08 square kilometres 0.31% of the Rideau Valley watershed
Land Use	77% urban 10% rural 7% forest 3% agriculture 3% wetland
Surficial Geology	77% clay 12% sand 5% diamicton 4% Paleozoic bedrock 2% organic deposits
Watercourse Type	*Watercourse Type:* 88% natural 12% channelized *Flow Type:* 95% permanent 4% intermittent 1% ephemeral
Invasive Species	There were twelve invasive species observed in 2015: common buckthorn, dog-strangling vine, European frogbit, garlic mustard, Himalayan buckthorn, honey suckle, Japanese knotweed, Manitoba maple, wild parsnip, purple loosestrife, yellow iris
Fish Community	33 fish species have been captured in Bilberry Creek historically including 12 game fish species

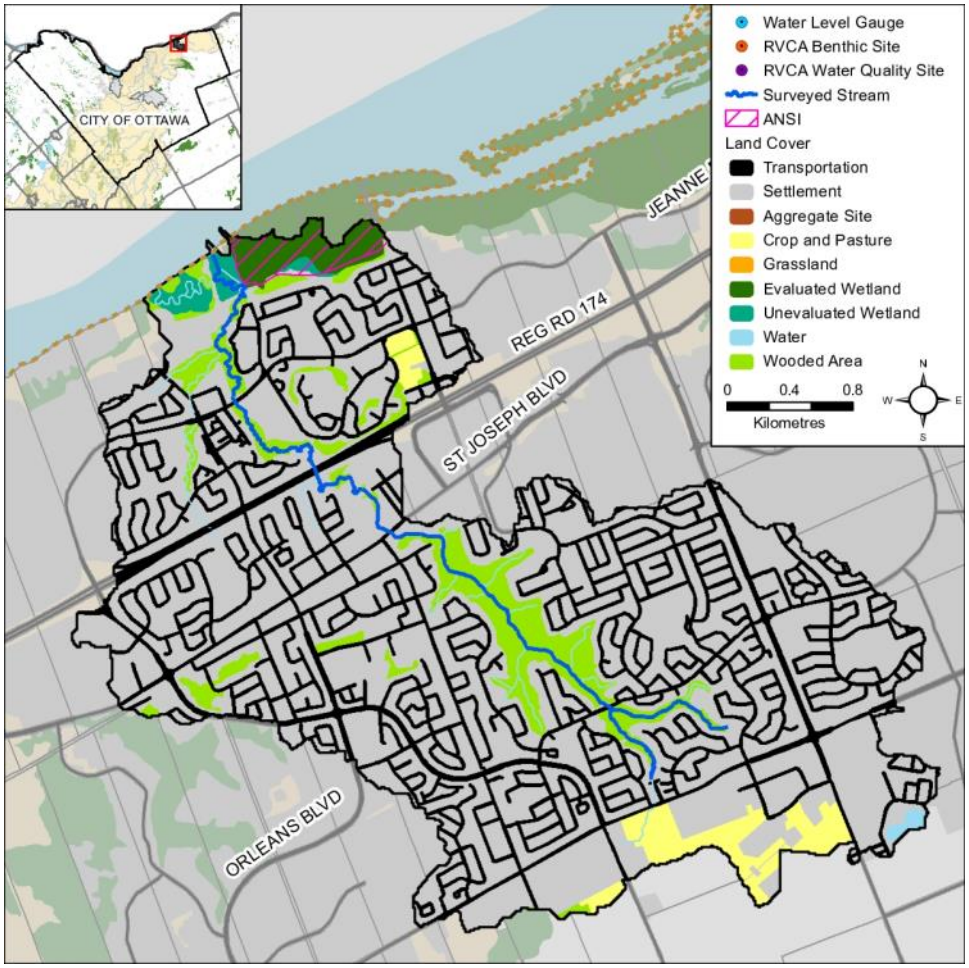


Figure 1 Land cover in the Bilberry Creek catchment

Woodlot Cover		
Size Category	**Number of Woodlots**	**% of Woodlot Cover**
10-30 ha	1	4
>30 ha	1	4

Wetland Cover
3% of the catchment is wetland

Upper reach of Bilberry Creek

The Rideau Valley Conservation Authority, in partnership with seven other agencies in Ottawa (City of Ottawa, Heron Park Community Association, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, National Defence HQ - Fish and Game Club, and the National Capital Commission) form the 2015 City Stream Watch collaborative.

Introduction

The headwaters of Bilberry Creek begin just north of Innes Road. From there, the creek runs though a forested ravine between housing subdivisions, crossing under St. Joseph Boulevard, Highway 174 and Jeanne D'Arc Boulevard prior to feeding into the Ottawa River. While the headwaters of Bilberry Creek run through a forested valley, the land use around the creek is intensive, putting a lot of pressure on the creek with stormwater runoff, especially during rain events. In 1945, the main branch of Bilberry Creek only had two major road crossings, and the land use was largely agricultural (RVCA, 2009). Since then, most of the subwatershed has been developed and many headwaters features have been lost. The remaining reaches have been greatly altered with piping, storm water drains, channelization and shoreline hardening including armourstone, rip rap, and gabion baskets (RVCA, 2009). Subwatershed development has resulted in channel widening and active erosion, and the stream is still in transition from those changes. During storm events, water is rapidly carried from the tributaries and stormwater drains of Bilberry Creek to the main branch, and water levels rise dramatically shortly after any precipitation. With such a rapid delivery of stormwater, contaminants from roadways and sewers are flushed directly into the creek and carried out into the Ottawa River.

In 2015, 71 sections (7.1 km) of Bilberry Creek were surveyed as part of the City Stream Watch monitoring activities. Surveying in 2015 included both branches of the creek north of Innes Road. The following is a summary of observations made by staff and volunteers along those 71 sections.

Bilberry Creek Overbank Zone

Riparian Buffer Width Evaluation

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: How Much Habitat is Enough?) is to maintain a minimum 30 meter wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Although Bilberry Creek does have some very well vegetated buffers in the south end of the creek it still does not meet the target above as it has a buffer width greater than 30 metres along 57 percent of the left bank and 58 percent of the right bank. Figure 2 demonstrates the buffer conditions of the left and right banks separately.

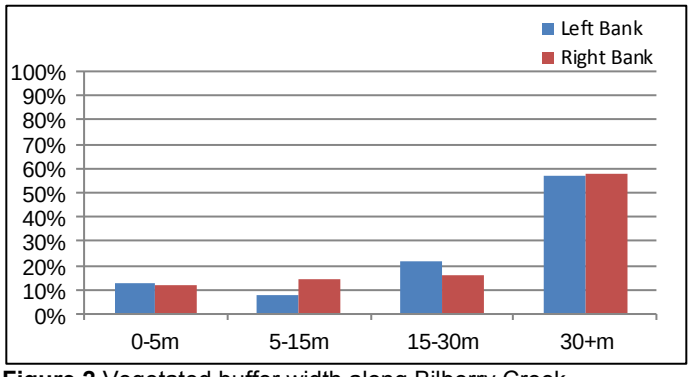


Figure 2 Vegetated buffer width along Bilberry Creek

Adjacent Land Use

The RVCA's Stream Characterization Survey Program identifies seven different land uses beside Bilberry Creek (Figure 3). Surrounding land use is considered from the beginning to end of each survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 65 percent of the surveyed stream, characterized by forest, scrubland, and meadow. Twenty five percent of the land use along the surveyed sections of the stream was made up of residential and recreational. The remaining ten percent of the land use surveyed was industrial/ commercial and infrastructure which includes road crossings and culverts.

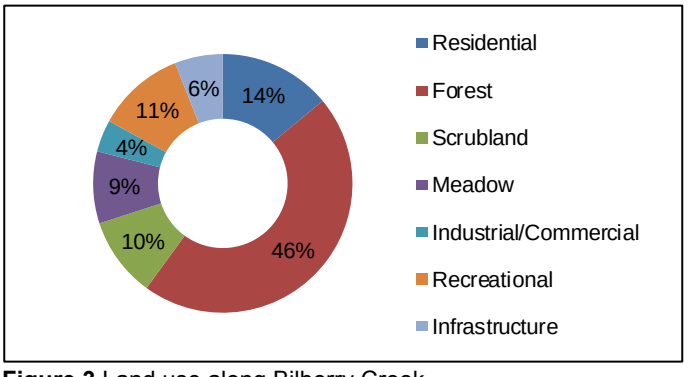


Figure 3 Land use along Bilberry Creek

Bilberry Creek Shoreline Zone

Erosion

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have a detrimental effect on important fish and wildlife habitat. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the potential to impact instream migration. Figure 4 shows that moderate levels of bank erosion were observed along most sections of Bilberry Creek. Very high active levels of erosion were observed from the mouth of the creek to just downstream of Jeanne D'Arc Boulevard as well as downstream of Des Epinettes Avenue in the south end of the creek.

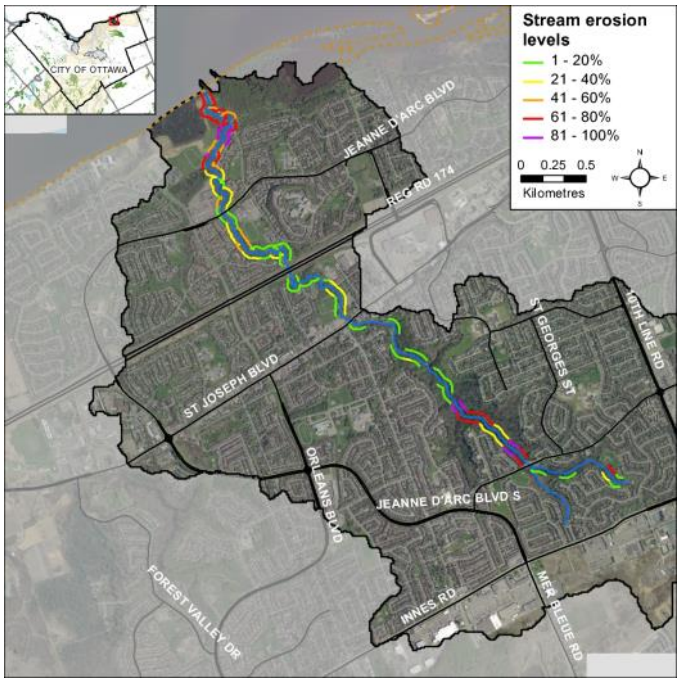


Figure 4 Erosion along Bilberry Creek

Active stream bank erosion on Bilberry Creek

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 5 shows that the bank undercutting on Bilberry Creek varied considerably. Much of the creek upstream of highway 174 had no bank undercutting interspersed with areas of low level undercutting. There were however, many sections with moderate and high levels of undercutting downstream of highway 174. The bank and substrate composition in this area is dominated by clay, and high levels of erosion were also observed so it is likely that the bank undercutting in this area is leading to bank failure over time.

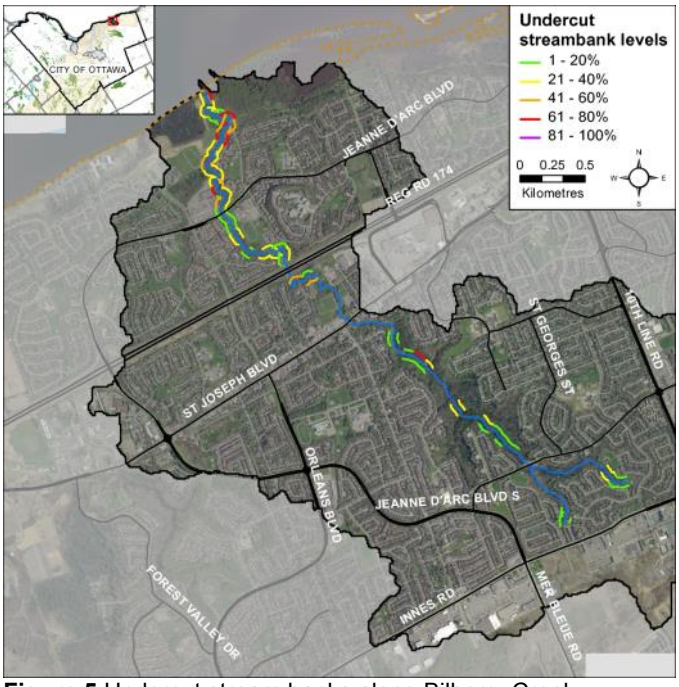


Figure 5 Undercut stream banks along Bilberry Creek

Bank undercutting on the right bank and erosion on the left bank of Bilberry Creek

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 6 shows stream shading along Bilberry Creek. High levels of shading were seen along most of the creek. Very high levels of shading were observed in the forested ravines in the southern portion of the creek.

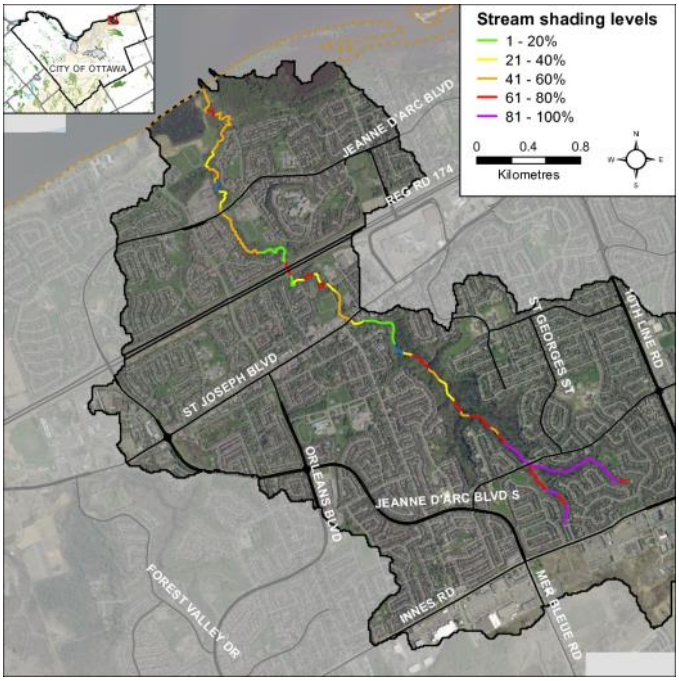


Figure 6 Stream shading along Bilberry Creek

Stream shade along Bilberry Creek

Instream Woody Debris

Figure 7 shows that overall, the surveyed sections along Bilberry Creek had moderate levels of instream woody debris in the form of branches and trees. High levels of woody debris were observed in areas where erosion has led to fallen trees accumulating in the creek. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas but large accumulations of woody debris resulting from erosion can lead to debris dams that may affect fish migration.

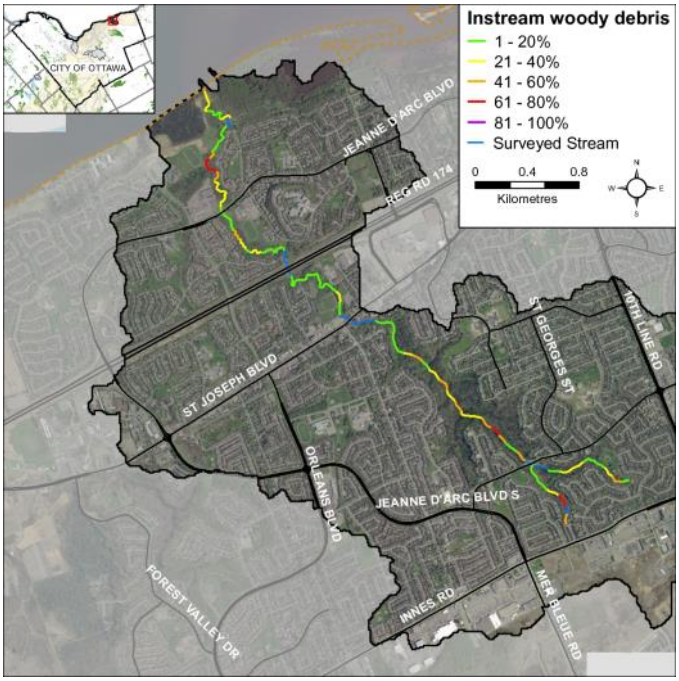


Figure 7 Instream woody debris along Bilberry Creek

High levels of Instream woody debris along Bilberry Creek

Overhanging Trees and Branches

Figure 8 shows that most of the sections surveyed on Bilberry Creek had moderate levels of overhanging branches and trees. Trees and branches that are less than one meter from the surface of the water are defined as overhanging. At this proximity to the water branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

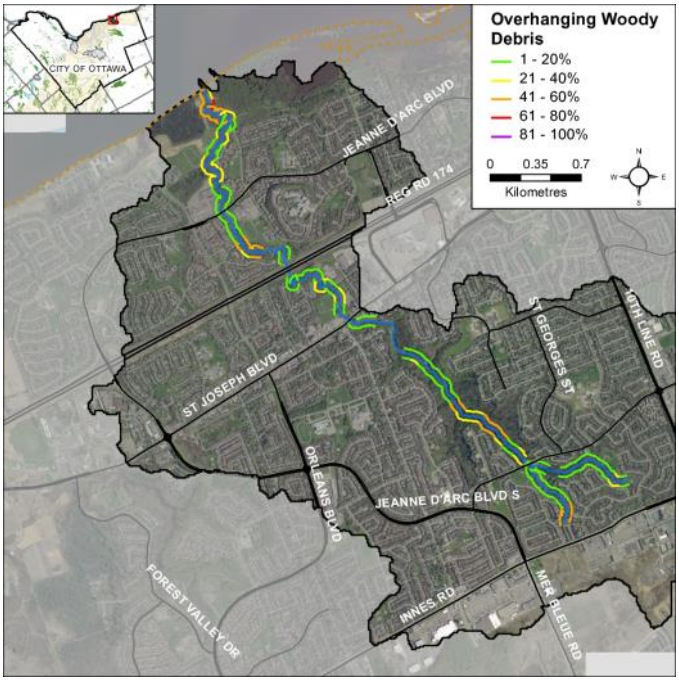


Figure 8 Overhanging trees and branches

Overhanging trees and branches on Bilberry Creek

Anthropogenic Alterations

Figure 9 shows that 70 percent of the sections on Bilberry Creek remain “unaltered” or "natural". Sections considered "altered" account for 11 percent of the stream, while 19 percent of the sections sampled were considered “highly altered”. The highly altered sections of Bilberry Creek refer to areas where the creek is channelized, runs through a culvert, or there is a road crossing with associated instream/shoreline modifications.

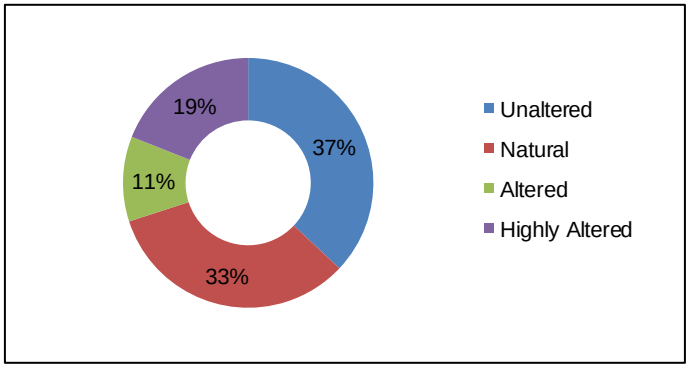


Figure 9 Anthropogenic alterations along Bilberry Creek

A highly altered section of Bilberry Creek which is channelized and reinforced by armour stone

Bilberry Creek Instream Aquatic Habitat

Habitat Complexity

Streams are naturally meandering systems that move over time with varying degrees of habitat complexity. Examples of habitat complexity include habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Overall, the habitat complexity of Bilberry Creek was high, demonstrated by the fact that 71 percent of the system was considered heterogeneous. Twenty nine percent of the system was considered homogeneous.

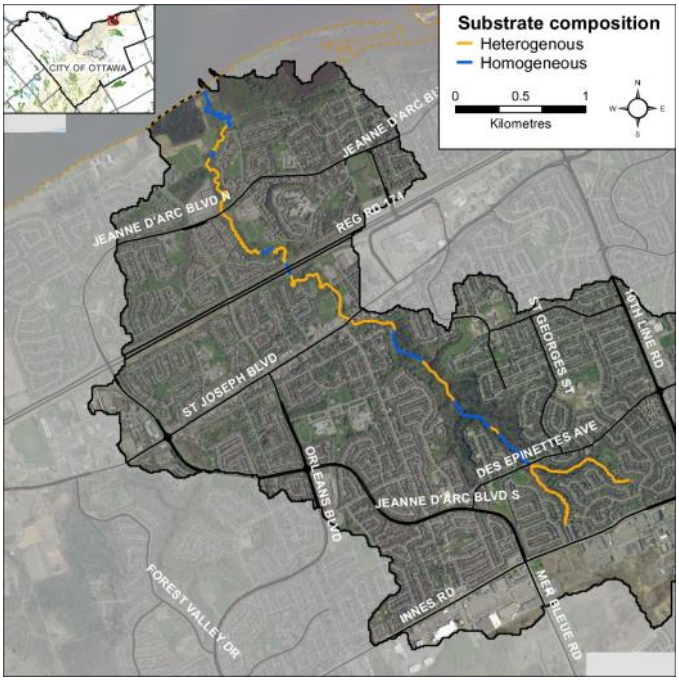


Figure 10 Instream habitat complexity in Bilberry Creek

Habitat complexity on Bilberry Creek

Instream Substrate

Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and, for example, will only reproduce on certain types of substrate. Figure 11 shows that 46 percent of the instream substrate observed on Bilberry Creek was clay. Twenty two percent of the substrate was recorded as silt and sand, 23 percent was made up of gravel and cobble, and the remaining nine percent was boulder and bedrock. Figure 12 shows the distribution of the dominant substrate types along the system. Clay was recorded most often as the dominant substrate downstream of highway 174 to the mouth of the creek, and between St. Joseph Boulevard and Des Epinettes Avenue.

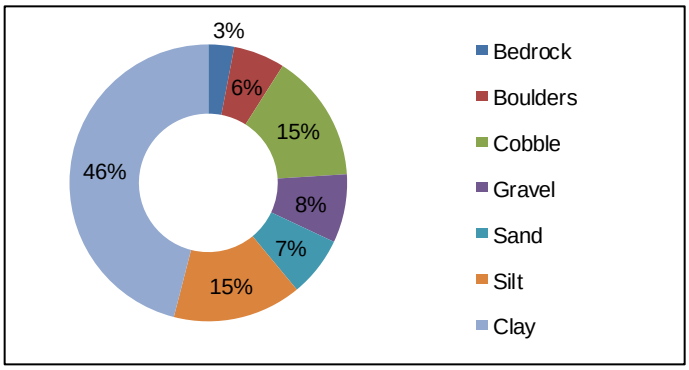


Figure 11 Instream substrate along Bilberry Creek

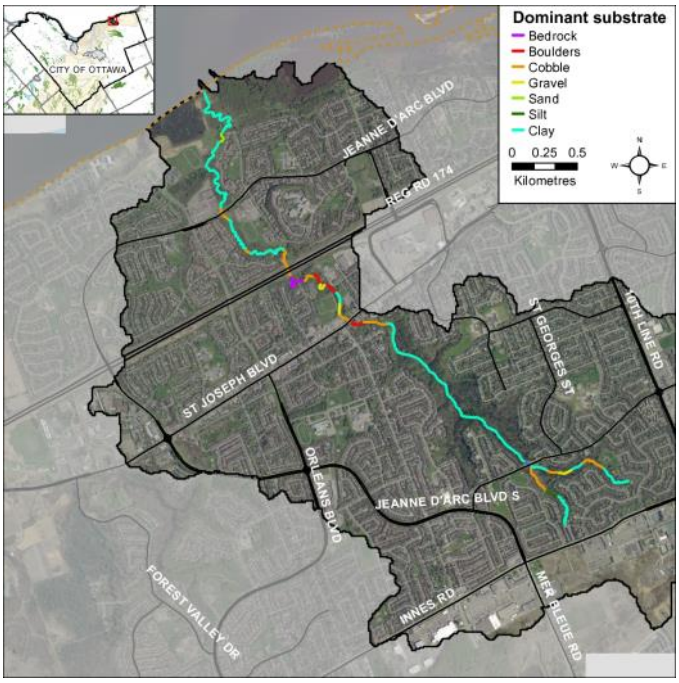


Figure 12 Dominant instream substrate in Bilberry Creek

Cobble and Boulder Habitat

Boulders create instream cover and back eddies for large fish to hide and rest out of the current. Cobble provides important over-wintering and spawning habitat for small or juvenile fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 13 shows the distribution of cobble and boulder habitat along Bilberry Creek. Areas of cobble and boulder habitat are dispersed throughout the stream but were most concentrated between Jeanne D'Arc Boulevard and St. Joseph Boulevard as well as in the upper reaches of the creek near Des Epinettes Avenue.

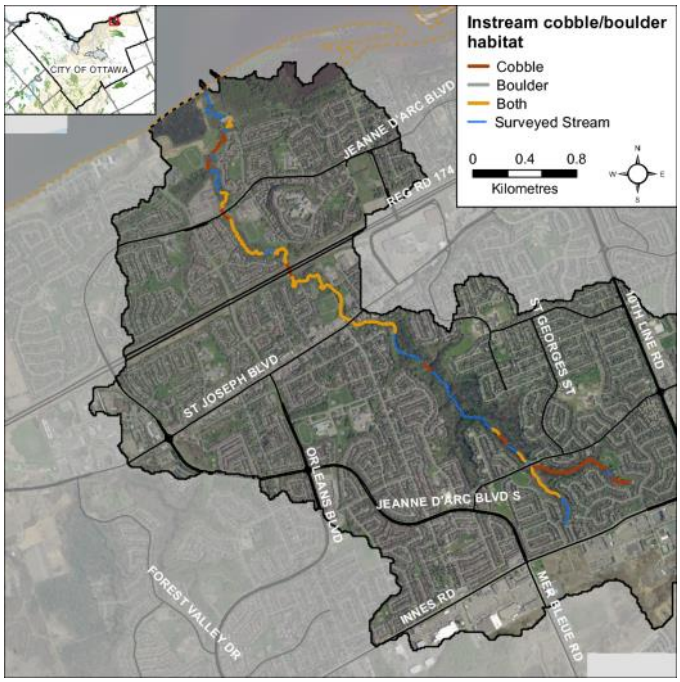


Figure 13 Cobble and boulder habitat in Bilberry Creek

Cobble and boulder habitat observed along Bilberry Creek

Instream Morphology

Pools and riffles are important habitat features for fish. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as sauger and walleye. Pools provide shelter for fish and can be refuge areas in the summer if water levels drop and water temperature in the creek increases. Pools also provide important over-wintering areas for fish. Runs are usually moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 14 shows that Bilberry Creek has good variability in instream morphology; 46 percent consists of runs, 43 percent consists of pools and 11 percent consists of riffles. Figure 15 shows where areas where riffle habitat was observed in Bilberry Creek. The riffle habitat was well dispersed along the entire length of the creek.

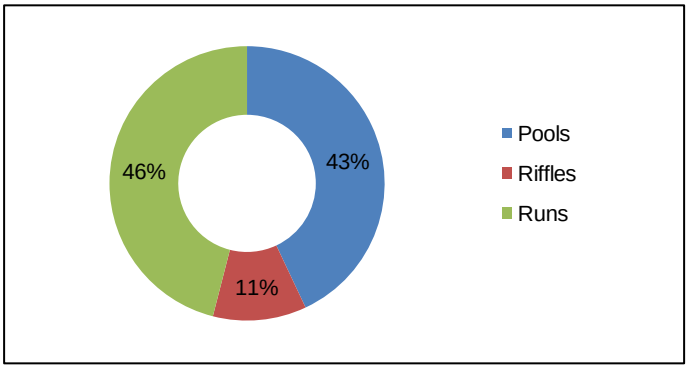


Figure 14 Instream morphology along Bilberry Creek

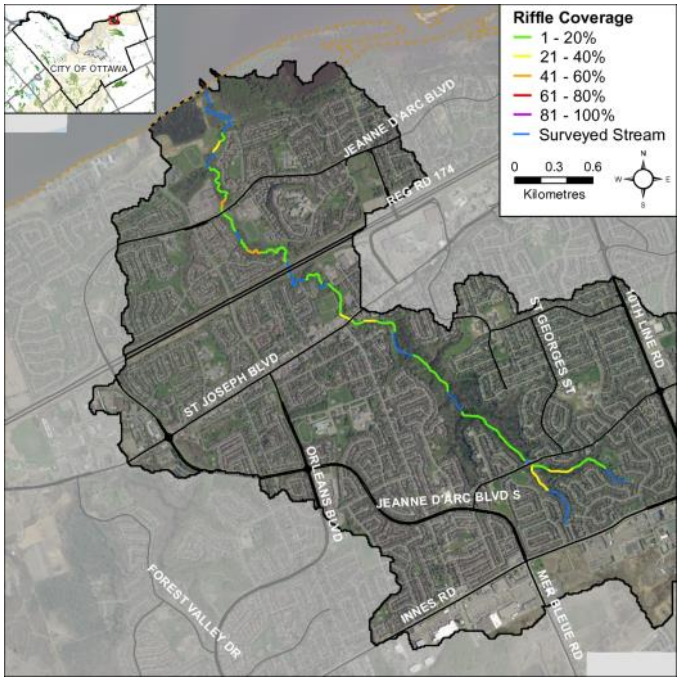


Figure 15 riffle coverage in Bilberry Creek

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. Figure 16 depicts the very low diversity present in the plant community structure of Bilberry Creek. The vegetation type observed in highest percentage, at 48 percent, is algae. Areas with no observable vegetation accounted for 43 percent and the remaining nine percent was a mix of narrow-leaved emergent plants, robust emergents, floating plants, and submerged plants. The distribution of overall dominant types of instream vegetation is reflected in Figure 17 showing that in most reaches no vegetation was observed.

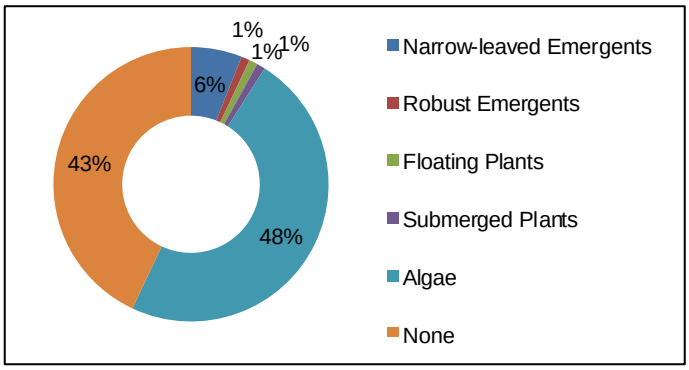


Figure 16 Vegetation types along Bilberry Creek

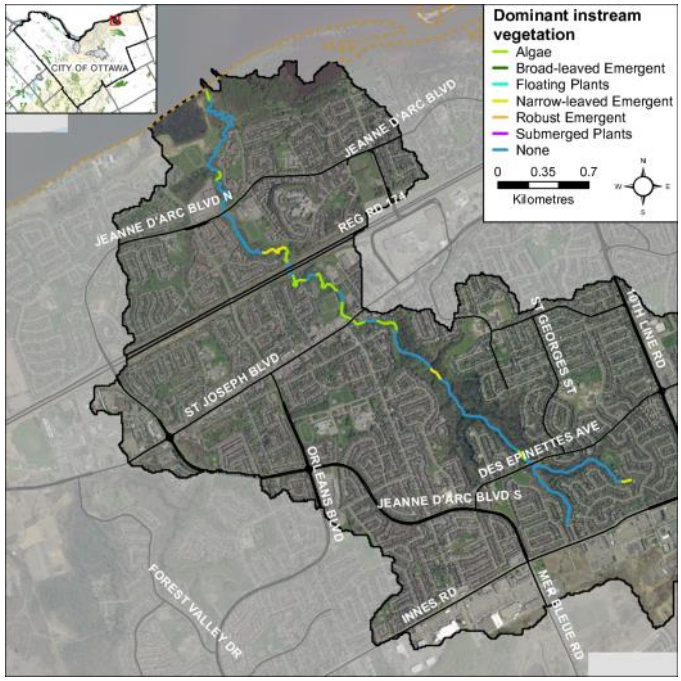


Figure 17 Dominant instream vegetation types

Instream Vegetation Abundance

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Too much vegetation can also be detrimental. Figure 18 demonstrates that overall Bilberry Creek had extremely low levels of instream vegetation. Areas of no vegetation accounted for 18 percent, rare levels accounted for 58 percent, low levels accounted for 23 percent and the remaining one percent were common levels. The low levels of vegetation on Bilberry Creek are the result of substrates dominated by clay and extreme fluctuations in water levels after rain events due to storm water runoff. Most types of vegetation, other than algae, have trouble establishing in these conditions.

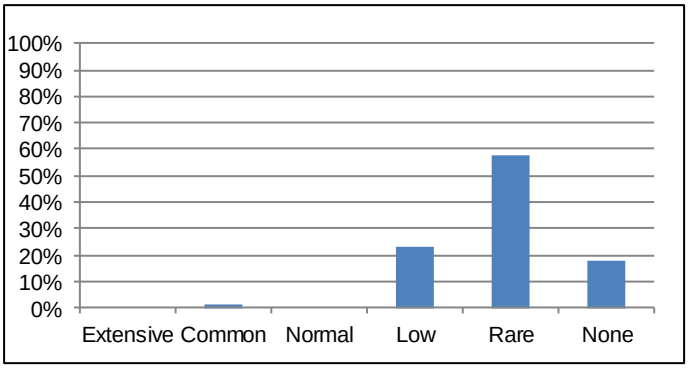


Figure 18 Instream vegetation abundance in Bilberry Creek

Extremely high water levels observed after a rain event

Bilberry Creek Stream Health

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. Invasive species were observed along 87 percent of the sections surveyed along Bilberry Creek (Figure 19). Figure 20 shows the variety of invasive species observed along Bilberry Creek. The invasive species that were observed most often were Manitoba maple (*Acer negundo*), purple loosestrife (*Lythrum salicaria),* common buckthorn (*Rhamnus cathartica*), Himalayan balsam (*Impatiens glandulifera*), and garlic mustard (*Alliaria petiolate*).

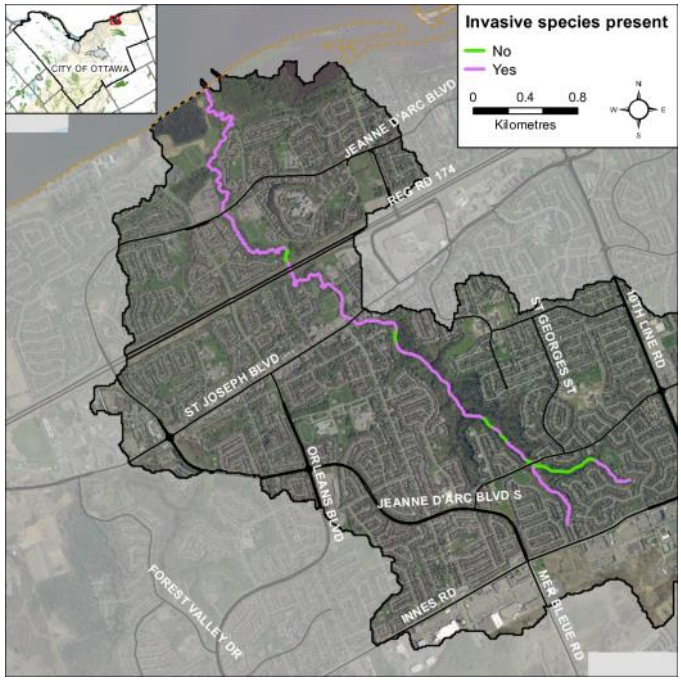


Figure 19 Presence of invasive species along Bilberry Creek

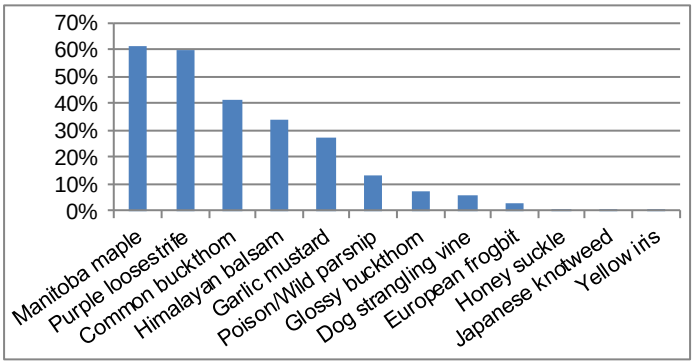


Figure 20 Invasive species observed along Bilberry Creek

Pollution

Figure 21 demonstrates the incidence of pollution/ garbage in Bilberry Creek. Only nine percent of the sections surveyed on Bilberry Creek did not have any observable garbage. Sixty nine percent had floating garbage, and 60 percent had garbage on the stream bottom. Many of the sections where garbage was observed had a combination of both floating garbage and garbage on the stream bottom.

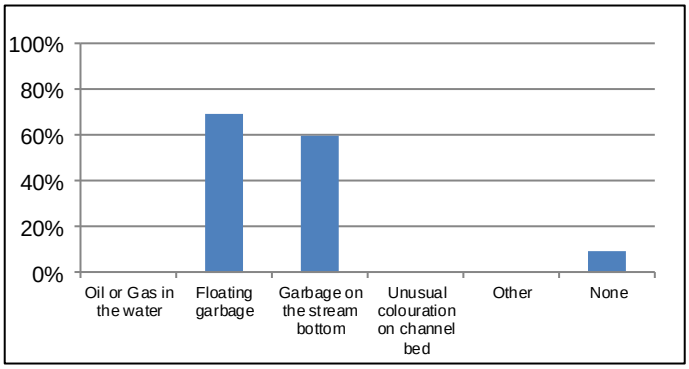


Figure 21 Pollution observed along Bilberry Creek

Wildlife

The diversity of fish and wildlife populations can be an indicator of water quality and overall stream health.

Wildlife	Observed
Birds	mallard, Canada goose, great blue heron, northern cardinal, blue jay, sparrow app., american crow, woodpecker spp., black-capped chickadee, chipping sparrow, downy woodpecker, american robin, pileated woodpecker, red-winged black bird, song sparrow, grackle, american goldfinch, hairy woodpecker, white-throated sparrow, field sparrow, wren spp., phoebe, sapsucker spp., gray catbird
Mammals	white tailed deer, groundhog, canine spp., north american beaver, raccoon, red squirrel, grey squirrel, black squirrel, chipmunk, fox, muskrat, vole
Reptiles Amphibians	snapping turtle, green frog, wood frog, leopard frog, pickerel frog
Aquatic Insects	water strider, crayfish spp., isopods
Other	damselfly spp., ebony jewelwing, swallowtail butterfly, bumblebee, mosquito, wasp, snail

Table 1 Wildlife observed along Bilberry Creek

Bilberry Creek Water Chemistry

Water Chemistry Measurement

During the stream characterization survey, a YSI probe is used to collect water chemistry information. Dissolved oxygen, conductivity and pH are measured at the start and end of each section.

Measuring water chemistry on Bilberry Creek using a YSI

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen dissolved in water. The Canadian Environmental Quality Guidelines of the Canadian Council of Ministers of the Environment (CCME) suggest that for the protection of aquatic life the lowest acceptable dissolved oxygen concentration should be 6 mg/L for warmwater biota (red line in Figure 22) and 9.5 mg/L for coldwater biota (blue line in Figure 22) (CCME, 1999). Figure 22 shows that all of the stretches of Bilberry Creek meet the standard for warmwater biota. The stretches of the creek downstream of St. Joseph Boulevard are all very close to, or just above, the threshold for coldwater biota ranging from 9.2 mg/L to 10.1 mg/L.

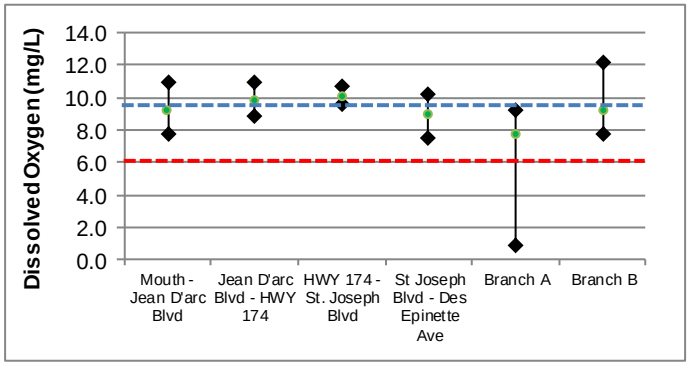


Figure 22 Dissolved oxygen ranges in Bilberry Creek

Conductivity

Conductivity in streams is primarily influenced by the geology of the surrounding environment, but can vary drastically as a function of surface water runoff. Currently there are no CCME guideline standards for stream conductivity, however readings which are outside the normal range observed within the system are often an indication of unmitigated discharge and/or stormwater input. The average specific conductivity observed within Bilberry Creek was very high overall at 1990 µs/cm. Figure 23 shows that the conductivity readings varied along the course of the creek. The lowest average specific conductivity reading on Bilberry Creek was 1639 µs/cm which was recorded in the stretch of the creek between Jeanne D'Arc Boulevard and Highway 174. The highest average conductivity readings were recorded in the first stretch of the creek downstream of Jeanne D'Arc Boulevard at 2414 µs/cm, and in Branch B which is the east branch in the upper reaches of the creek towards Innes Road which was recorded at 2805 µs/cm .

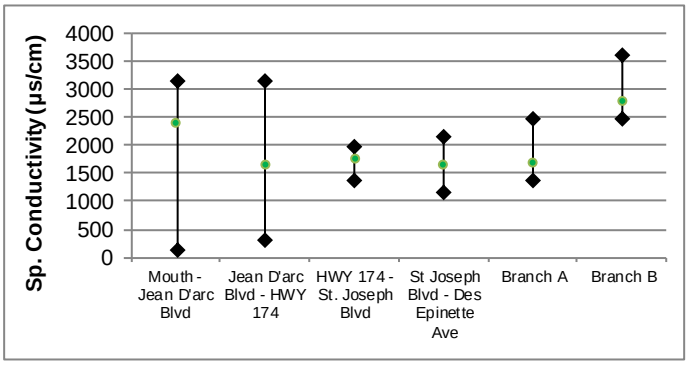


Figure 23 Conductivity ranges in Bilberry Creek

pH

Based on the PWQO for pH, a range of 6.5 to 8.5 should be maintained for the protection of aquatic life. Average pH values for Bilberry Creek ranged between 7.8 and 8.3, thereby meeting the provincial standard.

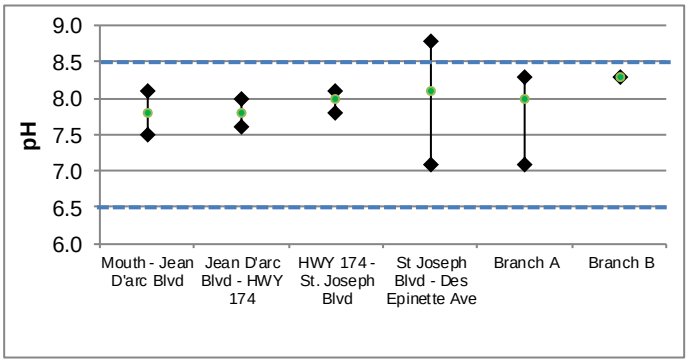


Figure 24 pH ranges in Bilberry Creek

Bilberry Creek Thermal Classification

Thermal Classification

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Three temperature loggers were deployed in the early spring to monitor water temperature in Bilberry Creek. Water temperature is used along with the maximum air temperature (using a revised Stoneman and Jones method) to classify sampling reaches into one of five categories that correspond to the thermal preferences of local fish communities (Figure 27). Figure 25 shows the locations where temperature loggers were installed on Bilberry Creek. Unfortunately logger 2 at St. Joseph Boulevard and logger 3 at Des Epinettes Avenue were not retrieved.

Analysis of the data collected from the logger at Jeanne D'Arc Boulevard indicates that the thermal classification of Bilberry Creek ranges between cool water and cool-warm water (Figure 27).

Groundwater

Groundwater discharge areas can influence stream temperature, contribute nutrients, and provide important stream habitat for fish and other biota. During stream surveys, indicators of groundwater discharge are noted when observed. Groundwater indicators include: springs and seeps, iron staining, significant water temperature change, rainbow mineral film and presence of watercress. Figure 26 shows areas where one or more groundwater indicators were observed during stream surveys on Bilberry Creek. Groundwater indicators were observed throughout Bilberry Creek.

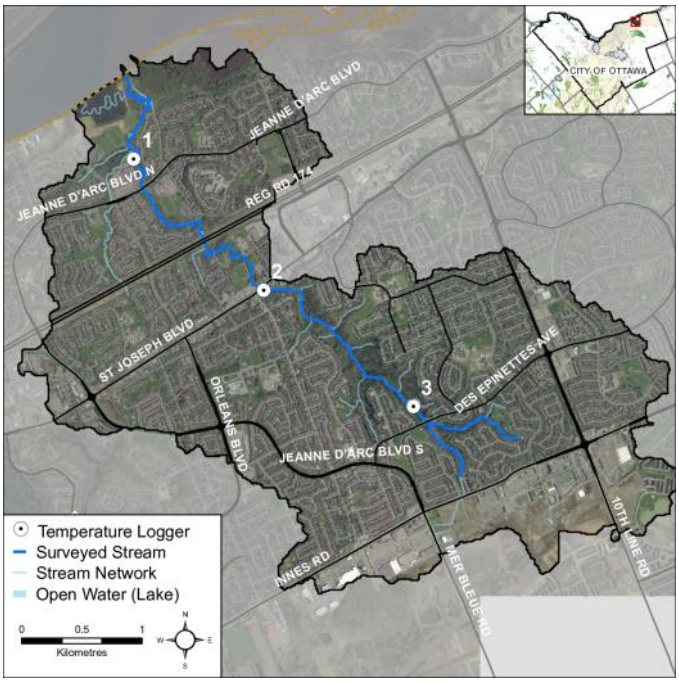


Figure 25 Temperature loggers along Bilberry Creek

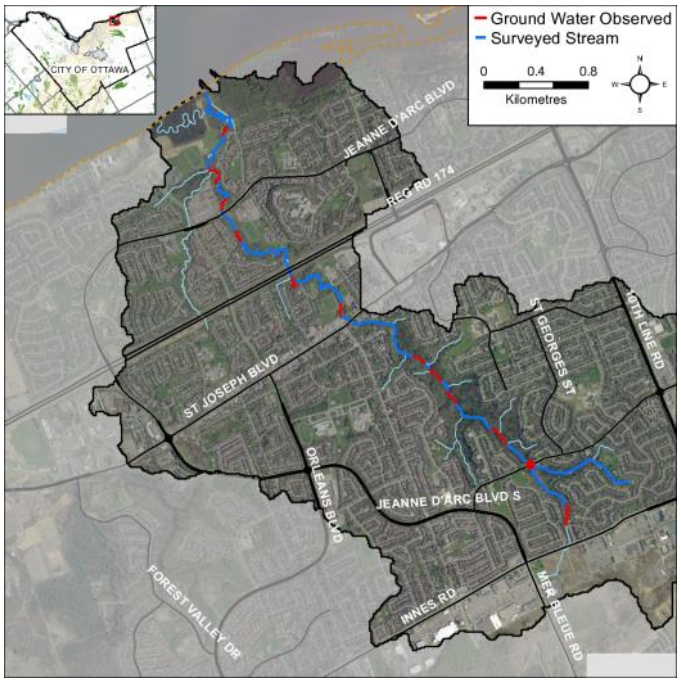


Figure 26 Groundwater indicators observed

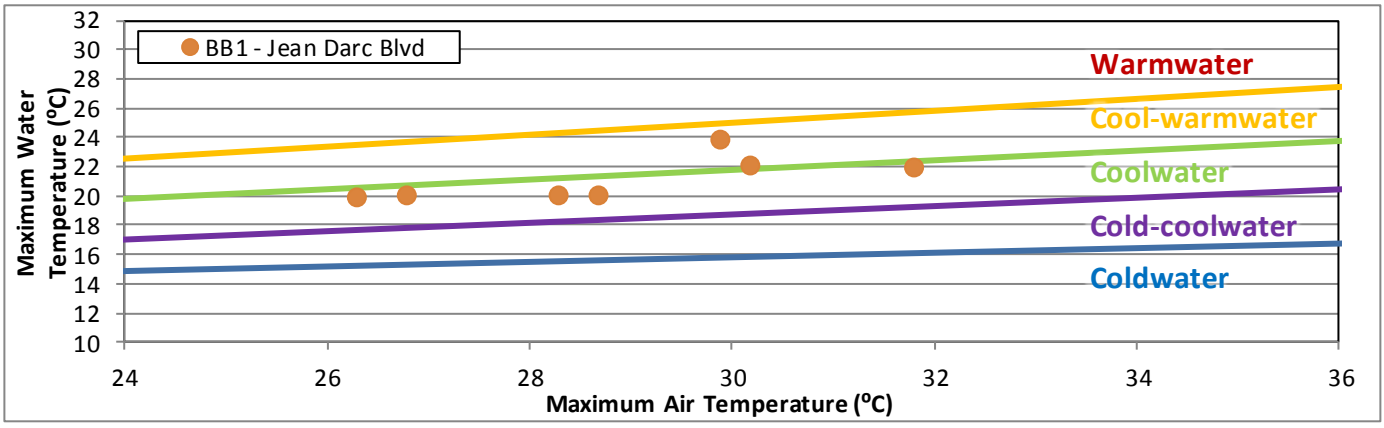


Figure 27 Thermal Classification for Bilberry Creek

Bilberry Creek Fish Community

Fish Community

Fish sampling sites located along Bilberry Creek are shown in Figure 28. The provincial fish codes shown in Figure 28 are listed (in Table 2) beside the common name of those fish species identified in Bilberry Creek. The thermal classification of Bilberry Creek ranges between cool water and cool-warm water, with thirty three fish species having been observed historically including 12 game fish species.

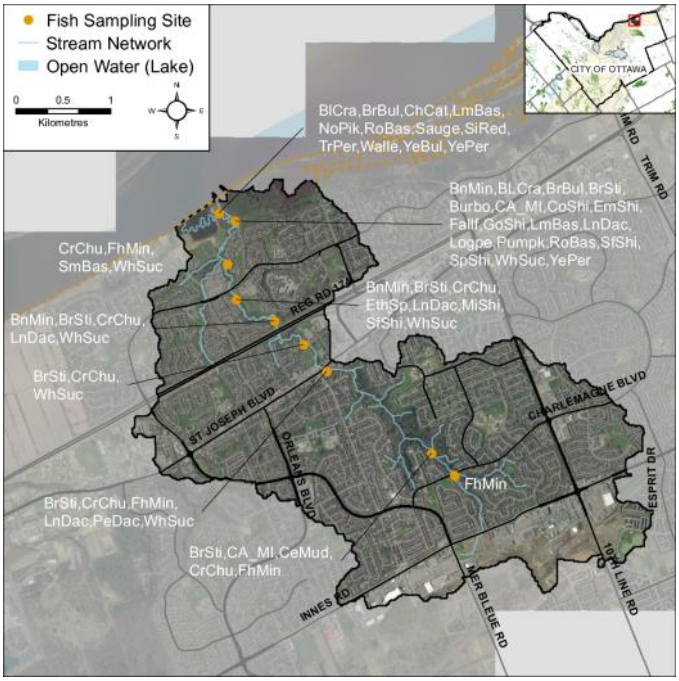


Figure 28 Bilberry Creek fish community

Volunteers pulling a seine net on Bilberry Creek

Species observed in Bilberry Creek (with fish code)			
black crappie	BlCra	longnose dace	LnDac
bluntnose minnow	BnMin	mimic shiner	MiShi
brook stickleback	BrSti	northern pearl dace	PeDac
brown bullhead	BrBul	northern pike	NoPik
burbot	Burbo	pumpkinseed	Pumpk
carps and minnows	CA_MI	rock bass	RoBas
central mudminnow	CeMud	sauger	Sauge
channel catfish	ChCat	silver redhorse	SiRed
common shiner	CoShi	smallmouth bass	SmBas
creek chub	CrChu	spotfin shiner	SfShi
emerald shiner	EmShi	spottail shiner	SpShi
Etheostoma sp.	EthSp	trout-perch	TrPer
fallfish	Fallf	walleye	Walle
fathead minnow	FhMin	white sucker	WhSuc
golden shiner	GoShi	yellow bullhead	YeBul
largemouth bass	LmBas	yellow perch	YePer
logperch	LogPe		

Table 2 Fish species observed in Bilberry Creek

Black crappie captured on Bilberry Creek

Sauger captured on Bilberry Creek

Migratory Obstructions

It is important to know locations of migratory obstructions because these can prevent fish from accessing important spawning and rearing habitat. Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. Figure 29 shows that along Bilberry Creek, multiple debris dams and two grade barriers were observed in the southern portion of the creek upstream of St. Joseph Blvd. The debris dams observed were the result of high levels of erosion in this area causing trees and debris to fall into the creek. The culverts located along Des Epinettes Avenue were both classified as grade barriers.

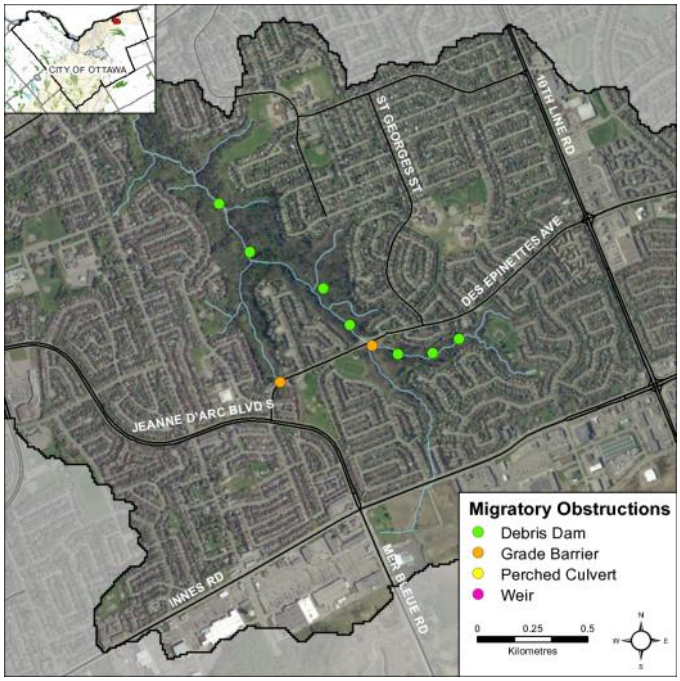


Figure 29 Bilberry Creek migratory obstructions

Beaver Dams

Beaver dams can also act as obstructions to fish migration. Figure 30 shows that in total 11 beaver dams were observed on Bilberry Creek all located between St. Joseph Boulevard and Des Epinettes Avenue. Seven of the beaver dams were active, four had been breached and one was abandoned. The head, or difference between the water level up and down stream, of the beaver dams ranged from 0 cm to 120 cm.

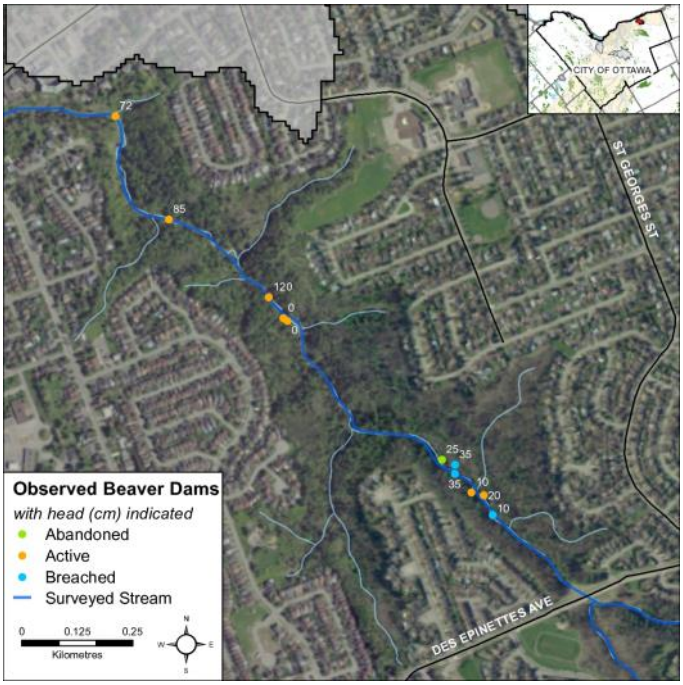


Figure 30 Beaver dams observed on Bilberry Creek

A debris dam observed along Bilberry Creek

A beaver dam observed on Bilberry Creek

Headwater Drainage Feature Assessment

Headwaters Sampling

The City Stream Watch program assessed Headwater Drainage Features for Barrhaven Creek, Bilberry Creek, Mosquito Creek and Stillwater Creek in 2015. This protocol measures zero, first and second order headwater drainage features (HDF). It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features (HDF). RVCA is working with other Conservation Authorities and the Ministry of Natural Resources and Forestry to implement the protocol with the goal of providing standard datasets to support science development and monitoring of headwater drainage features. An HDF is a depression in the land that conveys surface flow. Additionally, this module provides a means of characterizing the connectivity, form and unique features associated with each HDF (OSAP Protocol, 2013). The Bilberry Creek catchment area is heavily impacted by development pressures. Most of the headwater features which were historically connected to Bilberry Creek have been lost, filled in, or covered over by residential development that has taken place in the catchment area starting in the late 1970's. In 2015, the program sampled three headwater features in the Bilberry Creek catchment in the spring and summer seasons. Figure 31 demonstrates the 2015 Bilberry Creek sample locations.

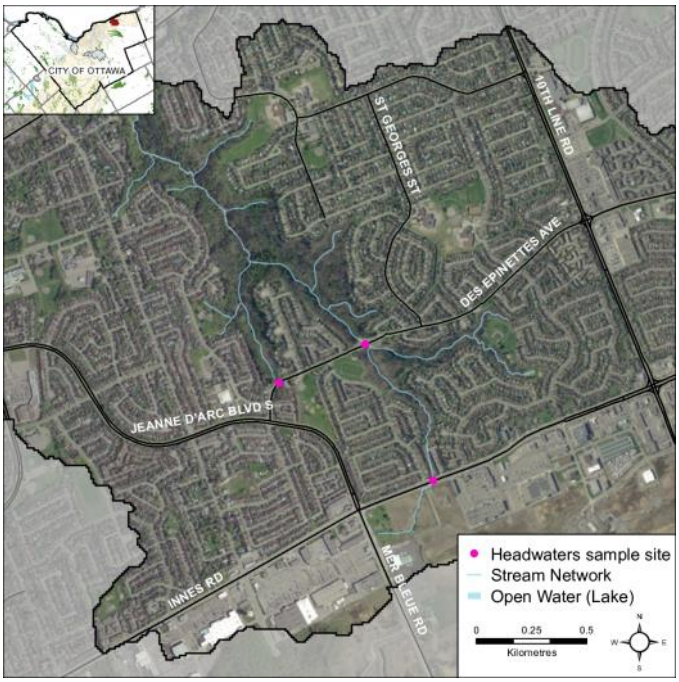


Figure 31 Bilberry Creek HDF sampling sites

Feature Type

The headwater sampling protocol assesses the feature type in order to understand the function of each feature. The evaluation includes the following classifications: defined natural channel, channelized or constrained, multi-thread, no defined feature, tiled, wetland, swale, roadside ditch and pond outlet. By assessing the values associated with the headwater drainage features in the catchment area we can understand the ecosystem services that they provide to the watershed in the form of hydrology, sediment transport, and aquatic and terrestrial functions. Heavily impacted by surrounding residential and commercial development, two of the headwater features that remain in the Bilberry Creek catchment are channelized and the other had no defined feature. Figure 32 shows the feature type of the primary feature at the sampling locations.

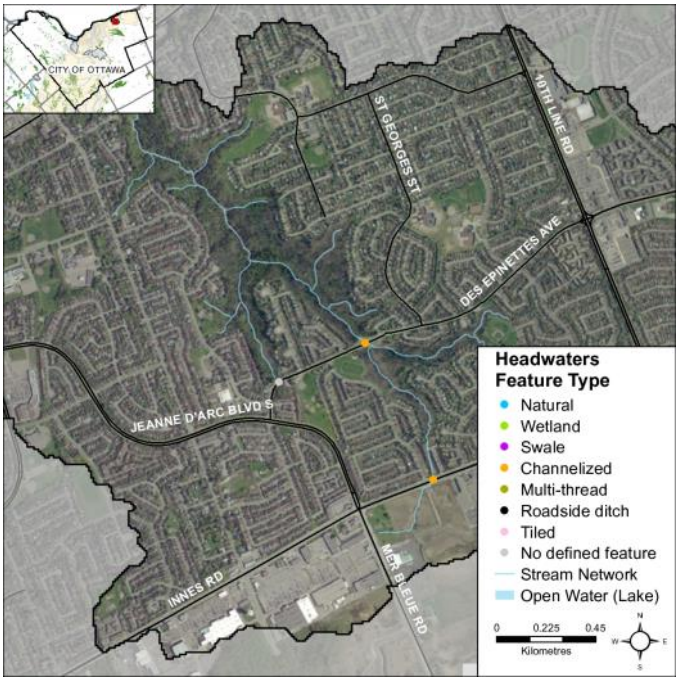


Figure 32 Bilberry Creek HDF feature types

Undefined HDF feature upstream of Des Epinettes Avenue

Headwater Feature Flow

The observed flow condition within headwater drainage features can be highly variable depending on timing relative to the spring freshet, recent rainfall, soil moisture, etc. Flow conditions are assessed in the spring and in the summer to determine if features are perennial and flow year round, if they are intermittent and dry up during the summer months or if they are ephemeral systems that do not flow regularly and generally respond to specific rainstorm events or snowmelt. Flow conditions in headwater systems can change from year to year depending on local precipitation patterns. Figure 33 shows the observed flow conditions at the sampling locations in the Bilberry Creek catchment. The sampling sites on Des Epinettes Ave were permanent features, whereas the feature on Innes Rd was intermittent.

Feature Channel Modifications

Channel modifications were assessed at each headwater drainage feature sampling location. Modifications include channelization, dredging, hardening and realignments. All of the sampling locations in the Bilberry Creek catchment were classified as having channel modifications. The sampling site closest to Jeanne D'Arc Blvd was classified as having channel hardening in the form of rip rap. The feature farther east along Des Epinettes Ave was classified as having mixed modifications in the form channel hardening, straightening, and barriers in close proximity. Finally, the site on Innes Road was classified as having mixed modifications. Figure 34 shows the channel modifications observed at the sampling locations for Bilberry Creek.

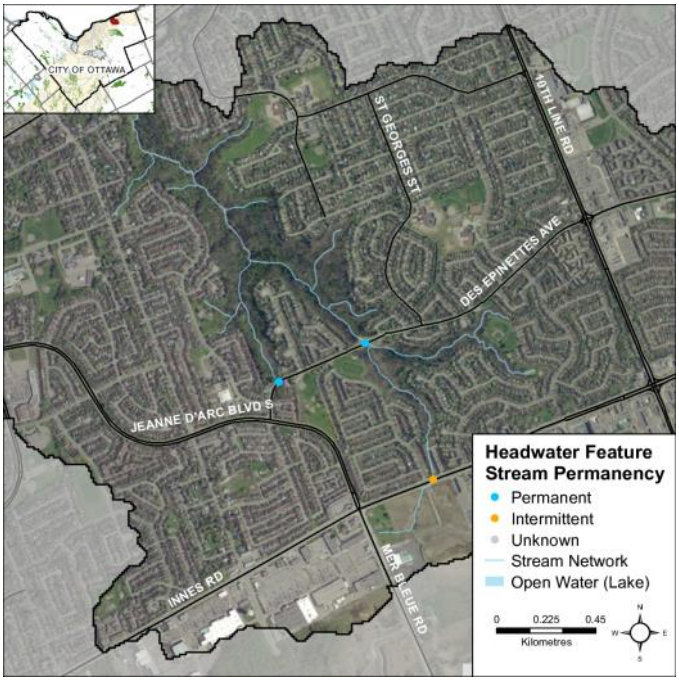


Figure 33 Bilberry Creek HDF flow conditions

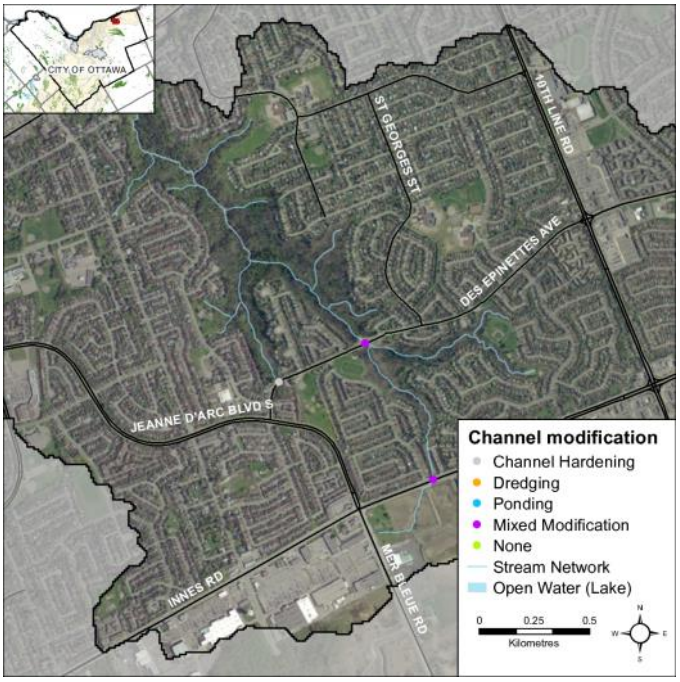


Figure 34 Bilberry Creek HDF channel modifications

Permanent HDF sampling site with observable flow in July

A stormwater feature forming part of the mixed modifications observed at an HDF site on Bilberry Creek

Headwater Feature Vegetation

Headwater feature vegetation evaluates the type of vegetation that is found within the drainage feature. The type of vegetation within the channel influences the aquatic and terrestrial ecosystem values that the feature provides. For some types of headwater features the vegetation within the feature plays a very important role in flow and sediment movement and provides wildlife habitat. The following classifications are evaluated: no vegetation, lawn, wetland, meadow, scrubland and forest. Figure 35 depicts the dominant vegetation type observed at both sampled headwater sites along Des Epinettes Ave was no vegetation due to the channel hardening which extended into the channel of both features. The site on Innes Rd was classified as having wetland feature vegetation.

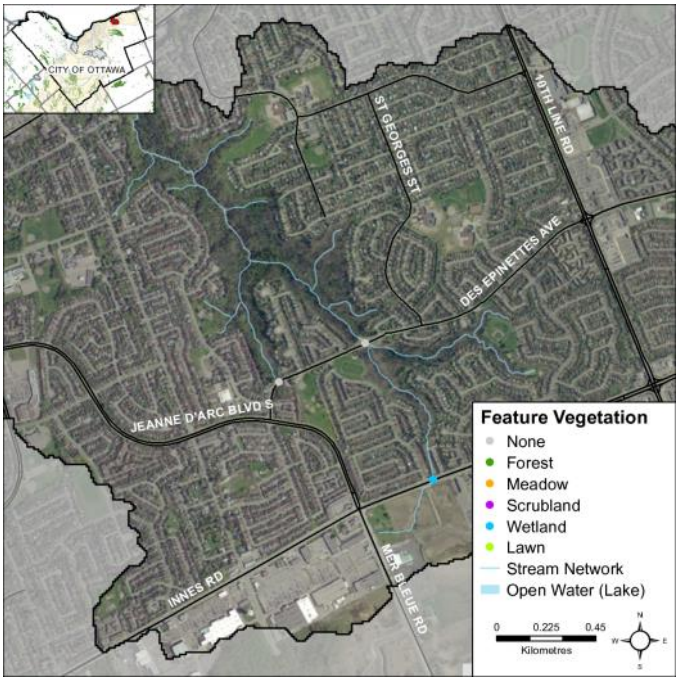


Figure 35 Bilberry Creek HDF feature vegetation

HDF with no vegetation due to rip rap in the channel

Headwater Feature Riparian Vegetation

Headwater riparian vegetation evaluates the type of vegetation that is found along the headwater drainage feature. The type of vegetation within the riparian corridor influences the aquatic and terrestrial ecosystem values that the feature provides to the watershed. Although impacted by development in close proximity, the riparian vegetation at the sample locations along Des Epinettes Ave were dominated by natural vegetation in the form of forest as a result of the forested buffer maintained around that section of Bilberry Creek. The site on Innes Rd was heavily impacted by recent commercial development as was classified as having unnatural riparian vegetation. Figure 36 depicts the type of riparian vegetation observed at the sampled headwater sites in the Bilberry Creek catchment.

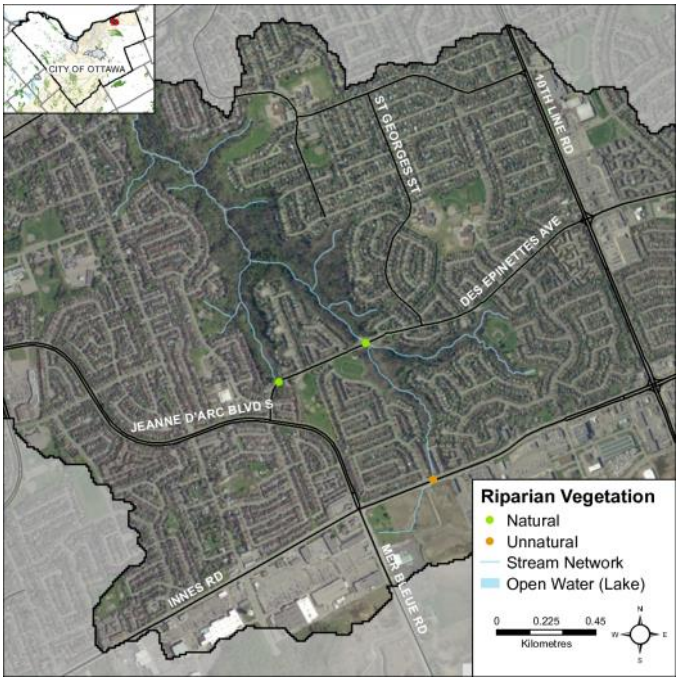


Figure 36 Bilberry Creek HDF riparian vegetation

Forested riparian buffer vegetation

Headwater Feature Sediment Deposition

Assessing the amount of recent sediment deposited in a channel provides an index of the degree to which the feature could be transporting sediment to downstream reaches (OSAP, 2013). Evidence of excessive sediment deposition might indicate the requirement to follow up with more detailed targeted assessments upstream of the site location to identify potential best management practices to be implemented. One site sampled in the Bilberry Creek catchment had no sediment deposition since the feature was entombed upstream, whereas the other features had substantial sediment deposition. Figure 37 depicts the degree of sediment deposition observed at the sampled headwater sites in the Bilberry Creek catchment.

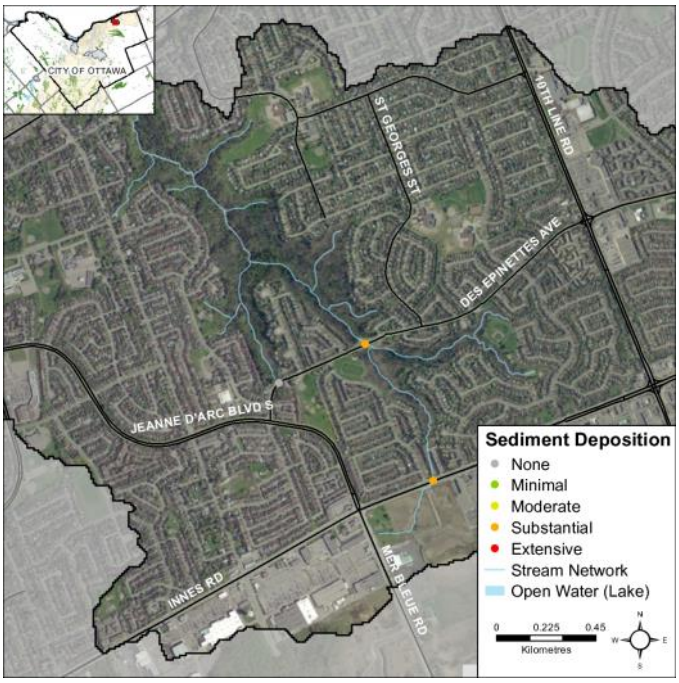


Figure 37 Bilberry Creek HDF sediment deposition

Headwater Feature Upstream Roughness

Feature roughness will provide a measure of the amount of materials within the bankfull channel that could slow down the velocity of water flowing within the headwater feature (OSAP, 2013). Materials on the channel bottom that provide roughness include vegetation, woody debris and boulders/cobble substrates. Roughness can provide benefits in mitigating downstream erosion on the headwater drainage feature and the receiving watercourse by reducing velocities. Roughness also provides important habitat conditions to aquatic organisms. Both samples locations along Des Epinettes Ave exhibited high feature roughness, and the site on Innes Rd exhibited extreme roughness. Figure 38 shows the feature roughness conditions at the sampling locations in the Bilberry Creek catchment.

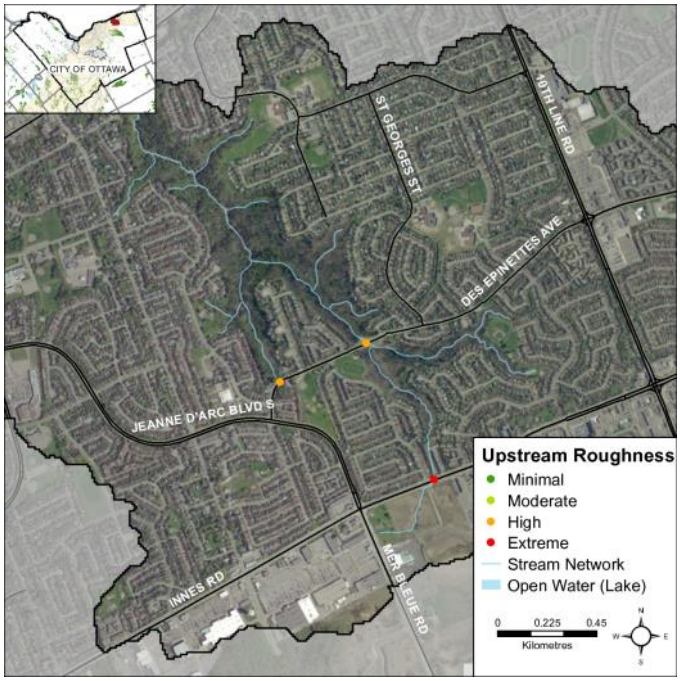


Figure 38 Bilberry Creek HDF feature roughness

Spring conditions at an HDF sampling site on Bilberry Creek

Summer conditions at the same HDF sampling site

Stream Comparison Between 2009 and 2015

The following tables provide a comparison of observations on Bilberry Creek between the 2009 and 2015 survey years. Bilberry Creek was also surveyed in 2004, but the surveying protocol has changed significantly since that time so data from 2004 cannot be compared to data from 2009 and 2015. In order to accurately represent current and historical information, the site data was only compared for those locations which were surveyed in both reporting periods. In some instances, this resulted in changes to our overall summary information. This information is therefore only a comparative evaluation and does not represent the entirety of our assessment.

Anthropogenic Changes

Table 3 shows that between 2009 and 2015 anthropogenic alterations along Bilberry Creek have shifted categories. In 2009, 29 percent of the sections had no anthropogenic alterations, in 2015 that number has increased to 39 percent. On the other hand, in 2009 six percent of the sections were highly altered, and in 2015 that number has increased to 17 percent. Given that highly altered sections and sections with no alternations have both increased, it is hard to determine if anthropogenic alterations have increased or decreased overall. The category shifts observed may be caused by changes in the stream survey protocol and the classification of channelization. In 2010 anthropogenic alterations were further defined in the protocol, which has caused some land uses to shift categories.

Anthropogenic Alterations	2009 (%)	2015 (%)
No anthropogenic alterations	29	39
"Natural" conditions with minor human alterations	39	33
"Altered" with considerable human impact but significant natural portions	26	11
"Highly altered" by humans with few natural portions	6	17

Table 3 Comparison of anthropogenic alterations along Bilberry Creek between 2009 and 2015

An highly altered section of Bilberry Creek

Bank Stability Changes

According to observations bank stability on Bilberry Creek has improved slightly overall since 2009. In 2009, 55 percent of the left bank and 58 percent of the right bank were considered stable. In 2015, 69 percent of the left bank and 68 percent of the right bank were stable. Although many sections of Bilberry Creek were considered stable there are areas where significant high levels of erosion were observed in 2015 especially in the forested ravine in the upper reaches of the creek.

Bank Stability	2009 (%) Left Bank	2009 (%) Right Bank	2015 (%) Left Bank	2015 (%) Right Bank
Stable	55	58	69	68
Unstable	45	42	31	32

Table 4 Comparison of bank stability along Bilberry Creek between 2009 and 2015

Changes in Instream Vegetation

Figure 39 shows that there has been an overall decrease in instream vegetation in Bilberry Creek since 2009. The amount of common levels of vegetation totaled 6 percent in 2009, and that number has decreased to zero in 2015. In addition, the amount of normal levels of vegetation totaled nine percent in 2009 and decreased to zero in 2015. Finally, the number of areas classified as having rare levels of vegetation or no vegetation has increased from 67 percent in 2009 to 78 percent in 2015. The decrease in instream vegetation may be in part attributed to stormwater influence on the system over time, but vegetation growth is also dependent on climatic variables as well as the stage of the growing season when observations took place.

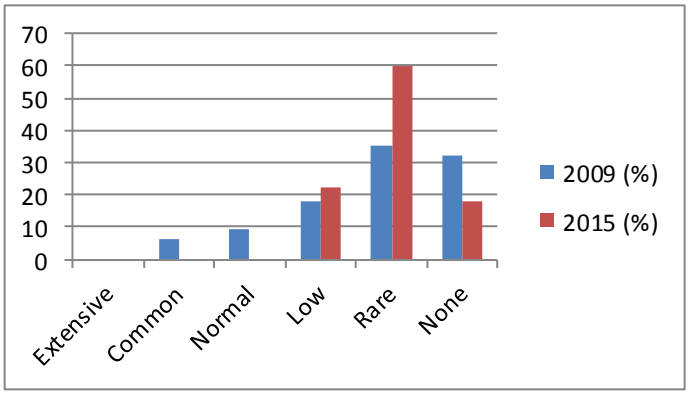


Figure 39 Comparison of instream vegetation levels

Changes in Pollution and Garbage

Overall the amount of pollution and garbage in Bilberry Creek has decreased slightly since 2009. Table 5 shows that the number of sections surveyed that were free from garbage has increased from five to nine percent since 2009.

Pollution/Garbage	2009 (%)	2015 (%)
None	5	9
Floating garbage	88	67
Garbage on stream bottom	55	58
Oil or gas trails	0	0
Discoloration of channel bed	2	0

Table 5 Comparison of pollution/garbage levels between 2009 and 2015

A shopping cart found in Bilberry Creek

Fish Community

Fish sampling was conducted on Bilberry Creek by the City Stream Watch program in 2004, 2009 and 2015. In total, 29 species of fish have been captured through City Stream Watch fish sampling efforts.
In 2004, 13 species were captured in five sampling sessions using a seine net. In 2009 fish sampling effort was significantly increased at the five sampling sites resulting in 17 species captured by seining, electrofishing and setting fyke and windemere traps. In 2015, 21 species were caught at seven sites using a combination of seine nets, electrofishing and fyke nets. Six species caught in 2009 were not found in 2015. This does not necessarily mean the species have disappeared from Bilberry Creek but species presence could be influenced by location, weather conditions, time of sampling and sampling method.

Species	Code	2004	2009	2015
black crappie.....	BlCra	X		X
bluntnose minnow.....	BnMin	X		
brook stickleback.....	BrSti	X	X	X
brown bullhead.....	BrBul		X	X
burbot.....	Burbo		X	X
carps and minnows...	CA_MI		X	
central mudminnow.....	CeMud		X	
channel catfish.....	ChCat			X
common shiner.....	CoShi		X	
creek chub.....	CrChu	X	X	X
emerald shiner.....	EmShi	X	X	
fallfish.....	Fallf		X	
fathead minnow.....	FhMin		X	X
golden shiner.....	GoShi	X		
largemouth bass.....	LmBas			X
logperch.....	LogPe	X		X
longnose dace.....	LnDac	X	X	X
northern pike.....	NoPik			X
pumpkinseed.....	Pumpk		X	X
rock bass.....	RoBas	X	X	X
sauger.....	Sauge			X
silver redhorse.....	SiRed			X
smallmouth bass.....	SmBas		X	
spotfin shiner.....	SfShi	X	X	X
spottail shiner.....	SpShi	X	X	X
walleye.....	Walle			X
white sucker.....	WhSuc	X	X	X
yellow bullhead.....	YeBul			X
yellow perch.....	YePer	X		X
Total Species		**13**	**17**	**21**

Table 6 Comparison of fish species caught in 2004, 2009 and 2015

Brown bullhead captured on Bilberry Creek in 2015

Monitoring and Restoration

Monitoring and Restoration Projects on Bilberry Creek

Table 7 below highlights the monitoring and restoration work that has been done on Bilberry Creek to date by the Rideau Valley Conservation Authority. Potential restoration opportunities are listed on the following page.

Accomplishment	Year	Description
City Stream Watch Stream Characterization Monitoring	2004	45 stream surveys were completed on Bilberry Creek
	2009	75 stream surveys were completed on Bilberry Creek
	2015	71 stream surveys were completed on Bilberry Creek
City Stream Watch Fish Sampling	2004	Six sites were sampled on Bilberry Creek
	2009	Five sites were sampled on Bilberry Creek
	2015	Seven sites were sampled on Bilberry Creek
City Stream Watch Thermal Classification	2004	Two temperature loggers were deployed
	2009	Four temperature loggers were deployed
	2015	Three temperature loggers were deployed
City Stream Watch Headwater Drainage Feature Sampling	2015	3 headwater drainage features were sampled in the Bilberry Creek catchment
City Stream Watch Riparian Planting	2009	City Stream Watch volunteers planted shrubs and trees along Bilberry Creek upstream of St. Joseph Boulevard
Shoreline Naturalization Program Planting	2011	City Stream Watch volunteers and program staff planted native shrubs and trees along Bilberry Creek in Yves Rocher Park and in the headwaters of the creek
	2012	City Stream Watch volunteers and program staff planted native shrubs and trees along Bilberry Creek in Pierre Rocque Park
City Stream Watch Stream Cleanup	2010	City Stream Watch Volunteers removed debris of human origin from three sections of Bilberry Creek
	2013	City Stream Watch volunteers removed debris of human origin from Bilberry Creek near Jeanne D'Arc Boulevard
	2015	City Stream Watch volunteers removed debris of human origin from Bilberry Creek at Pierre Rocque Park and near Jeanne D'Arc Boulevard
City Stream Watch Invasive Species Removal	2015	City Stream Watch volunteers removed invasive Himalayan Balsam from the shoreline of Bilberry Creek near Jeanne D'Arc Boulevard

Table 7 Monitoring and Restoration on Bilberry Creek

A volunteer performing stream surveys on Bilberry Creek

Volunteers removing Himalayan balsam from Bilberry Creek

Potential Riparian Restoration Opportunities

Figure 40 depicts the locations where City Stream Watch staff and volunteers observed areas where the riparian zone could be restored or enhanced using one or more of the following techniques: riparian planting, erosion control, invasive species control and wildlife habitat creation.
The majority of the opportunities listed were invasive species control riparian planting and erosion control. The areas highlighted for invasive species control were where the species Himalayan balsam was observed. The areas highlighted for erosion control were downstream of highway 174 and downstream of Bilberry Drive towards the mouth of the creek.

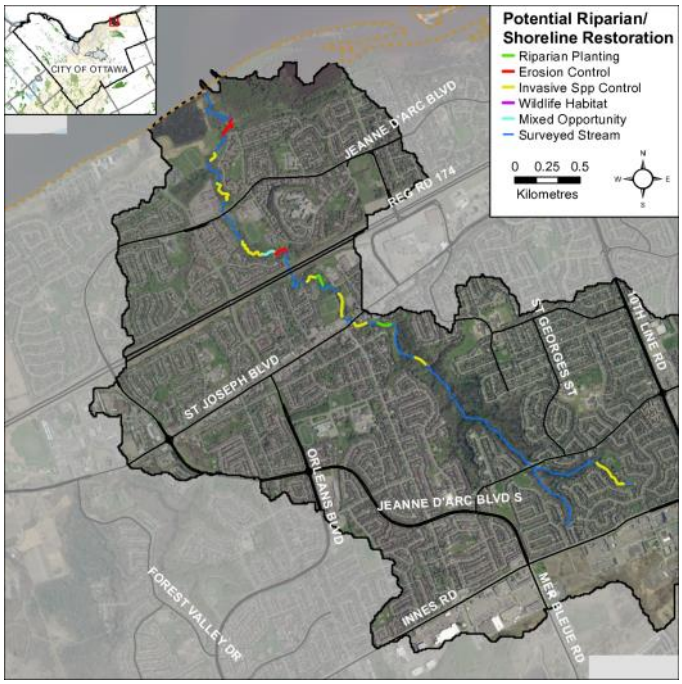


Figure 40 Potential riparian/shoreline restoration opportunities

Potential Instream Restoration Opportunities

Figure 41 depicts the locations where City Stream Watch staff and volunteers made note of areas where there were one or more of the following instream restoration opportunities: fish habitat enhancement, garbage cleanup and channel modification.
All of the opportunities listed for Bilberry Creek were stream garbage cleanups. Most of the garbage noted throughout the creek appeared to be washed downstream through the system where it collects on woody debris.

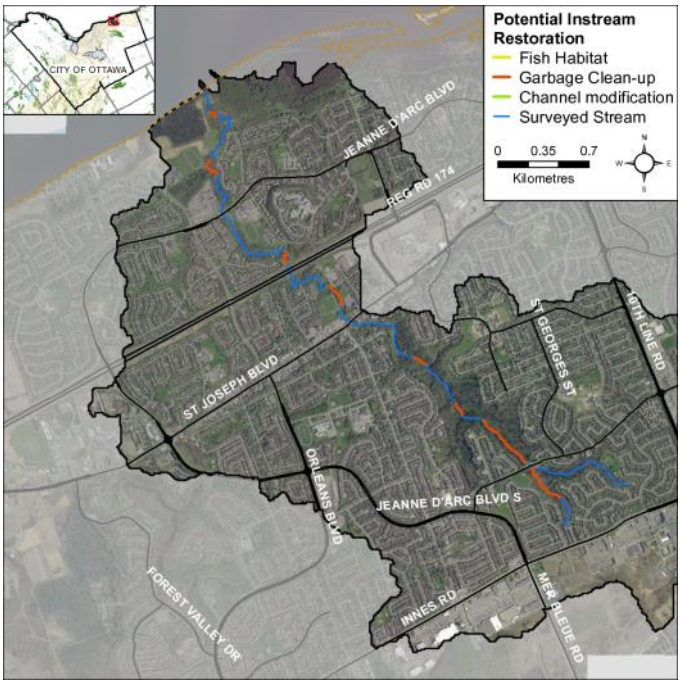
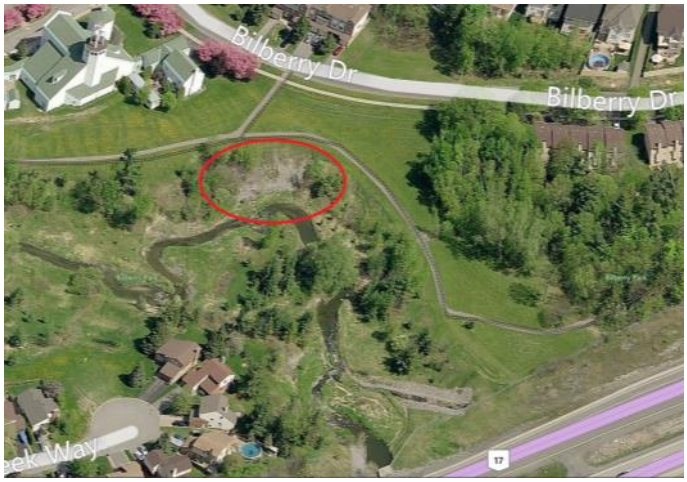


Figure 41 Potential instream restoration opportunities



Erosion control opportunity along Bilberry Creek downstream of Highway 174

Garbage caught on woody debris in Bilberry Creek



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For more information on the overall 2015 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2015 Summary Report.